Appendix E

Spatial Analysis Temperature Tools

Overall Function: This appendix describes the tools that should be provided in DDAP to analyze how temperature typically varies over the Basin both with elevation and from one time of the year to another. The results will vary depending on the historical period of record and how the results are interpreted by the user performing the analysis, thus a PETA must be selected prior to using these tools.

PETA Selection

When the Spatial Temperature category is chosen, the user should first be given a list of PETAs that exist for the Basin. The user will then choose the appropriate PETA. How the tools are applied will also depend on whether the HPOR is being analyzed or whether the record is being extended, thus the user will also need to select the period to be worked on from a list of available periods defined for the chosen PETA.

Basic Display: One the PETA and the period of record have been selected, the basic display for the Spatial Temperature tools window should contain the following in addition to overlay, zoom, query, and units features:

• Basin boundaries - i.e. the overall boundaries of the Basin currently selected as specified in the Basin definition (not Watershed boundaries), and

• All temperature stations that have been previously selected for use for analyzing precipitation patterns for the Basin and PETA (see Station Selection tool in this appendix).

Menus

Control and Tools menus should be included. The Control menu only needs a Quit option. The tools menu should contain the following options:

• Station Selection,
• Compute Monthly Means,
• Delete Stations, and
• Temperature versus Elevation.

Each of the Spatial Temperature tools are described in this appendix starting on separate pages.

Data Base Considerations: As with precipitation, as discussed in Appendix C, there are two ways to store and maintain information for each temperature station. This appendix assumes that temperature stations will be handled just like precipitation stations in that a single file will be

maintained for any station that is used in any temperature analysis. The best estimate of any consistency corrections and mean monthly max and min temperatures would be stored. Since mean monthly values are dependent on the HPOR used, sets would have to be maintained for each such period. Besides the best estimates, any prior values of these quantities would also need to be kept in the data base file (along with the associated Basin and PETA). Typically the best estimate from a prior analysis would be used for any subsequent analysis unless the user specifically rejected a value and established a new best estimate. This approach makes it less likely that stations would use different consistency corrections and monthly averages from one analysis to another.

Station Selection

Function: To select the stations with historical temperature data that should be included in the analysis for the selected Basin, PETA, and period of record.

Modification to the Basic Display: When the Station Selection tool is chosen, the basic Spatial Temperature tools display is modified to show in addition to the stations previously specified, all other stations with historical temperature data for the period of record being analyzed that lie within the latitude, longitude box surrounding the Basin. These stations should be in a different color than those already selected (note - any stations not chosen, should be removed from the basic Spatial Analysis Temperature tools display when the user quits the Station Selection tool).

User Specification: The user selects a station and then after examining the information available for that station using the query function, indicates whether the station should be included for the given Basin and PETA. If the station has different types of temperature data, the user can make a separate choice for each type (currently only max and min temperature data are used for historical analysis, but it is recommended that instantaneous data should be included). It may be wise to indicate in some way which stations have been rejected, at least during this session, so that the user knows which stations have already been examined.

The capability should also be provided with the Station Selection tool to merge the records for two or more stations together for use in the analysis. In many cases stations in the NCDC climatological network are moved from one location to another nearby site. In some cases the station identifier is not changed and the move is just reflected in the meta data. In other cases the station is discontinued and a new station established. In many of these cases it is easier to treat the record as a single location with moves than as several different stations.

Output: As the user accepts a given station for use in the analysis, the station, along with a max/min or instantaneous indicator, is added to the list of temperature stations to be included for the Basin and selected PETA. It should also be noted when the station was added to the analysis, i.e. during the HPOR or a specific extension period. For merged records, the observed data and meta information for each of the original stations should be combined into a single new station (should be clearly identified as a merged record). If there are overlaps in the merged records, the user should designate which original station's data should be used during these periods.

Compute Monthly Means

Function: To produce mean monthly max and min temperature values for the HPOR for each station for a given Basin and PETA. Also used to check the consistency of the temperature records and make any needed corrections.

Method: This tool should utilize the method described in Section 6-4 of the Calibration Manual to determine mean monthly max and min temperatures in a consistent manner (analogous to procedure included in the current PXPP program for precipitation). This approach would use the average difference between the max and min values for each temperature station and a base station to determine mean monthly estimates for the HPOR. Station consistency would be checked and corrections applied as needed utilizing IDMA capabilities. For stations with instantaneous data, max and min values would be determined and consistency corrections applied as in the OFS MAT preprocessor function (described in outline form in Section II.7-OFS-MAT of the NWSRFS User's Manual). The input and how the results are utilized will depend on whether some of the stations have been involved in a prior analysis (either for another Basin or a different PETA for this Basin) and whether one is working with the HPOR or an extension. When working with the HPOR, the run period is the historical period of record. When working with an extension, the run period can begin at or prior to when the extension begins and go through the end of the extension period.

- When working with the HPOR:
  ◦ For stations that have consistency corrections defined from a prior analysis, the currently defined best estimates of these corrections should be used as input. If the user decides to change a prior correction, the prior values should be maintained with an indication of the prior analyses to which they apply.
  ◦ For stations that have mean monthly max/min temperature values defined for the same HPOR, the values derived with this analysis should be compared to the established prior best estimates. The user can then decide whether the new values should replace the existing best estimates. If so, the prior values should be maintained as with consistency corrections (there are bound to be some differences in the monthly means derived from each analysis since the base station used will vary as well as the estimator stations).

- When working with an extension to the HPOR (in this case mean values are only being determined for those stations that were not part of the HPOR analysis):
  ◦ For stations that have consistency corrections defined from a prior analysis for the extension period, the currently defined best estimates of these corrections should be used. If the user decides to change any of these corrections, the prior values should be maintained with an indication of the prior analyses to which they apply. Consistency corrections that apply prior to the beginning of the extension period shouldn't be allowed to be changed.
  ◦ Mean monthly values for those stations that were not part of the HPOR analysis are computed by taking the differenc to the base station determined this analysis and adding it to the best estimate of the mean monthly values for the base station for the HPOR.

Again, if these stations have mean monthly max/min temperature values defined for the same HPOR from a prior analysis, the values derived should be compared to the established prior best estimates. The user can then decide whether the new values should replace the existing best estimates. For all stations that were part of the HPOR analysis, the mean monthly values can't be changed when running an extension period.

User Specifications:
- Beginning of the run if an extension period,
- Station to be used as the base station (for an extension period run, the base station must have mean monthly values defined for the HPOR),
- Indicator as to whether consistency checks are to be made (yes or no),
- Option to display average max and min temperature values for each station - only valid for a HPOR run, and
- Specification of how to group stations on double mass plots - currently a max of 5 stations on a plot (default is to use prior grouping for this tool for the Basin and PETA, if available, with any stations not included noted).

Displays Generated:
- Tabular display showing a summary of the program input and a listing for all stations for each month showing the number of cases used, the difference between max and min temperatures and the base station values, and the derived mean monthly max and min temperatures, plus the average annual max and min temperature for each station,
- Tabular display of the average max and min temperature for each month for each station with an indication of whether the value is observed or estimated (only if option to output monthly temperatures is 'on'), and
- Plots of the difference to base of max and min temperatures for all stations - probably no more than 10 stations per plot.

Output: (when the user Okays the results)
- Derived mean monthly max and min temperatures whenever values are first generated or the user specifies that the current best estimate is to be changed,
- Derived consistency corrections whenever values are first generated or the user specifies that current corrections are to be changed, and
- Specification of how stations are grouped on double mass plots (latest grouping stored).

Delete Stations

Function: To remove stations previously selected using the Station Selection tool.

User Specification: User selects each station to be removed from the spatial analysis. Stations can only be removed when working with the HPOR.

Output:
- Remove station from list of stations for the Basin selected for the PETA, and
- Remove any mean monthly values and consistency corrections stored with the station information that are unique to the current Basin and PETA,

Temperature versus Elevation

Function: To see how max and min temperature varies with elevation on a monthly basis for the HPOR.

Input: (all from previously stored information)
  • Stations are all those selected for the Basin and PETA using the Station Selection tool,
  • Elevations come from the meta data file for each station and are based on the current location of the site,
  • Mean monthly max and min temperature values for the HPOR for each station are obtained from the values generated by the Compute Monthly Means tool.

User Specification:
  • Indicator to use current best estimate of the mean monthly precipitation for each station or to use the prior estimate for this Basin and PETA if different from the current best estimate.

Steps and Displays Generated:
  1. Generate plots of max and min temperatures versus elevation for each month in the general form of Fig. 6-4-3 in the Calibration Manual. Max and Min temperatures should be in a different color with a different plot symbol. In addition, the -0.6°C lapse rate should be shown as a guide. User then defines the best linear relationship for max and min temperatures for each month (defined by intercept at sea level and lapse rate).
  2. Produce a plot of derived lapse rates for max and min temperatures versus months of the year as shown in Fig. 6-4-4 of the Calibration Manual. User can modify any of the lapse rates to get a more consistent seasonal pattern.
  3. Regenerate plots of max and min temperatures versus elevation for each month using lapse rates from Step 2 (Step 1 plots). User can shift the intercept or completely redefine the best linear relationship for max or min values on any plot. If user okays the results go to Step 4, if not, repeat Steps 2 and 3 until done.
  4. Generate map plots for max and min temperature for each month (24 plots) with the deviation of the temperature for each station from the best linear relationship shown at the location of the station (used to determine if a spatial pattern exists for the deviations). User decides if a spatial pattern exists. If a pattern exists, go to Step 5, if not, finished.
  5. User defines iso-deviation lines for max and min temperatures for each month.

Output:
  • Definition of best linear relationship between max and min temperature and elevation for each month, and
  • If spatial patterns defined, maps of how the deviations from the best linear relationships vary over the Basin for max and min values for each month.